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This report summarizes results obtained in the study of how waves are reflected and transmitted by a randomly layered medium. ~~We assume that~~ temporally pulsed energy (plane wave, beam or radiated energy from a localized source) illuminates this material. Work that was initially done for the acoustic problem has been extended to the electromagnetic problem. An extensive simulation study has confirmed the applicability of this theory. Recent work has considered radiation from a monochromatic point source in the presence of a randomly layered medium.

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FINAL TECHNICAL REPORT

PULSE PROPAGATION IN RANDOM MEDIA

AFOSR GRANT AFOSR-88-0112

for the period

1 MARCH 1989 - 30 APRIL 1990

BY WERNER KOHLER

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Work on this grant has continued an ongoing study of wave propagation in a randomly layered environment. The work initially done on the scalar acoustic problem has been extended to the vector electromagnetic case. Our results are presented in a manuscript, "Reflection of Pulsed Electromagnetic Waves From a Randomly Stratified Half Space" by Werner Kohler, George Papanicolaou, Marie Postel and Benjamin White, that has recently been submitted for publication to the J. Optical Society of America A.

The basic problem considered has been that of a dissipative, weakly dispersive, randomly layered half space adjoined to a homogeneous half space at a plane interface. Time-limited, pulsed electromagnetic energy is incident upon the random half space from the homogeneous region. We have considered the cases of normally and obliquely incident plane waves as well as the case of excitation by a point current source. Both polarizations have been accounted for. We have been principally interested in determining the statistics (mean value and correlation function) of the reflected electric field at the plane interface. Theoretical results have been evaluated and compared with the results of an extensive simulation study. This comparison has shown the theory to be quite good.

Recent work has considered the case of a monochromatic (CW) point source in the presence of the randomly layered half space. In this problem we again consider a hierarchy of scales, delineated by a small parameter ϵ. In this case, the correlation length of the random microstructure is again assumed to be $O(\epsilon^2)$ and the deterministic background or macroscale is taken to be $O(1)$. The wavelength of the CW source is, in this instance, assumed to have an intermediate scale $O(\epsilon)$ length. We are interested in the statistics of both reflected and transmitted fields when the source is positioned above the randomly layered half space. We are also interested in studying the case where the point source is buried within the random medium. This work is currently in progress. Results thus far have been quite encouraging. We have been able to derive particularly simple (potentially quite useful) expressions for the reflected coherent field, the transmitted coherent field and the reflected intensity, when the source lies above the random medium.

In addition to the manuscript submitted to J. Optical Society of America A, the work performed

under this grant has been reported in the following presentations:

* One hour talk (by George Papanicolaou) at the 1989 AMS - SIAM Summer Seminar on the Mathematics of Random Media, Blacksburg, VA, June 1989. A paper co-authored by Papanicolaou, White and Kohler will appear in the conference volume to be published by the American Mathematical Society.
* Invited talks at the PIERS Symposium (July, 1989) and the Venice - 1 Symposium (October 1989) were mentioned in the last report.

Due to a family matter which arose, I was unable to give an invited talk at the SIAM New Orleans meeting (March 1990); Marie Postel went in my place. I will be discussing this work at a workshop to be held at the USAF School of Aerospace Medicine in August 1990. I have also accepted an invitation to speak at the 1990 IMACS Symposium to be held in Dublin in July, 1991.